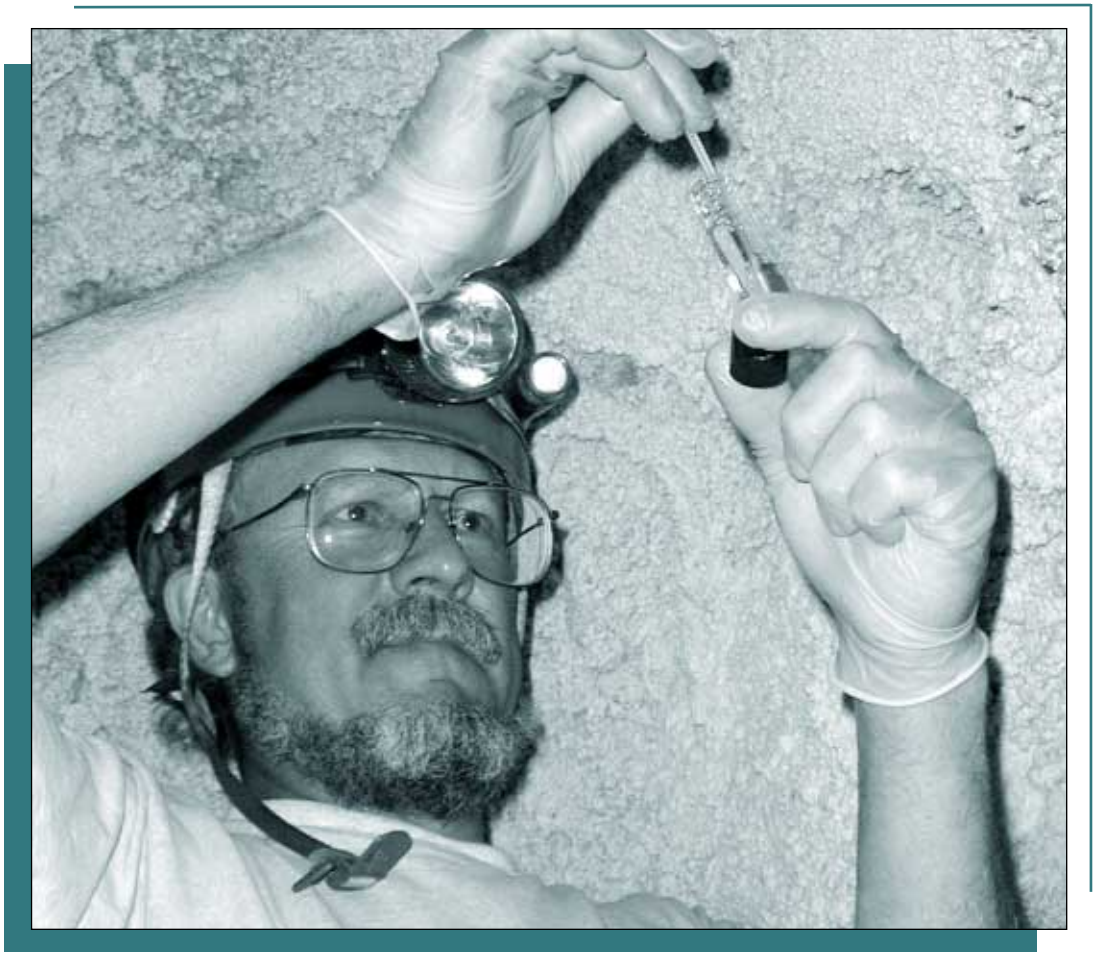
2000 Parks as Laboratories



▲ **Cave scientist Michael Spilde** of the University of New Mexico prepares a sample of limestone corrosion residue taken from the wall of Spider Cave in Carlsbad Caverns National Park for examination in the laboratory. Like nearby Lechuguilla Cave, Spider Cave harbors diverse microbial life. Both caves are being studied for insights into the evolution of life in these subterranean environments where nutrient levels are extremely low.
Copyright 2001 by Kenneth Ingham, used by permission

The parks themselves are wonderful natural laboratories, relatively well controlled, where species can be investigated in depth [and] where the whole constellation of species found in individual areas can be explored … on a large scale.

—Peter Raven
President-elect, American Association for the Advancement of Science

Featuring some of the best-preserved ecosystems on earth, the many units of the national park system are great repositories of biological and geological diversity. The scientific knowledge and applications that are being discovered in these strongholds have the great potential to improve society and enhance the protection of the parks themselves. To bring such discoveries to light, the National Park Service relies on its research partners to design and conduct experiments that yield useful information. Conversely, scientists look to the National Park Service for access to parks and for leadership in research on biodiversity, ecology, and conservation. As the following articles suggest, this relationship is growing and must continue to grow. Recent research and scientific advances are adding to our knowledge of parks and improving their management, and national parks are increasingly fulfilling a vital role in the quest for knowledge and understanding of our world.

Social Benefits of Park Research

Survival in extreme environments

✎ By Paul Burger

✉ paul_burger@nps.gov
Hydrologist, Carlsbad Caverns National Park, New Mexico

The discovery of a small rock—Martian meteorite ALH84001—on an Antarctic ice field in 1984 and the discovery of possible Martian fossil bacteria on the rock in 1994 sparked a search for life in extreme environments where organisms subsist with few organic nutrients. Such extreme environments include caves, and caves are preserved in many units of the national park system.

In 2000, scientists from the University of New Mexico continued their six-year search for life in caves of Carlsbad Caverns National Park, New Mexico. They braved pits that are more than 200 feet (60 meters) deep and mazes of tight, dirty crawls. With the help of cave specialists of the National Park Service, the scientists discovered previously unknown bacteria on the walls and in the pools of several caves.

Some bacteria are hidden in mats of red, black, and orange corrosion residues on the cave walls where they obtain energy from tiny amounts of iron and manganese in the limestone bedrock. These bacteria may be analogs for life beneath the stony, barren surface of Mars where satellite imagery and samples revealed large amounts of iron in rock.

In Lechuguilla Cave, only 1 mile (1.6 kilometers) from the world-famous Carlsbad Cavern, pools are also teeming with life. According to Dr. Larry Mallory, a microbiologist with Biomes, Inc., "There is more biodiversity in some of the pools of Lechuguilla than in the Amazon jungle." By releasing enzymes that kill competitors, the bacteria in these pools compete fiercely with each other for the few available nutrients. Testing in the laboratory revealed that some of these enzymes attack leukemia cells and may someday become instrumental in cures of human diseases.

Unfortunately, foreign bacteria shed from human skin, hair, and clothes harm the native microbes by outcompeting them for food. Additionally, food particles, flakes of dead skin, hair lint, and dirt left behind by people can overwhelm portions of the cave's nutrient-poor ecosystem, altering it in favor of exotic surface microbes. Only a few contacts with cave explorers have already decimated native microbe populations in some of the pools of Lechuguilla Cave. Explorers and scientists, who often camp in the cave for several days, are now required to eat and sleep on drop cloths that catch food, skin, and hair. Furthermore the explorers are restricted from approaching pools they discover and are required to report their discoveries to the Cave Resources Office of the park and to the investigators of the University of New Mexico. Scientists approach the pools in Tyvek clean suits and set up clean glass slides that remain in the cave for as many as five years. After the slides are collected, scientists culture the bacteria in a laboratory and attempt to isolate important enzymes to gain an understanding of life in extreme environments.

Continuing research will further an understanding of the complex ecosystems and life-forms in the caves of Carlsbad Caverns National Park. Already the studies reveal the delicacy of these organisms and the importance of appropriate management of the caves.

▲ **Rich in bacteria and fungi,** cave wall corrosion residue may form as a result of microbial metabolism of inorganic elements such as iron and manganese. Geobiologists studying this phenomenon in several near-pristine caves in Carlsbad Caverns National Park hypothesize that these microbial life processes hold clues to the potential for subterranean life on Mars.
Copyright 2001 by Kenneth Ingham, used by permission

National Cave and Karst Research Institute begins organizational phase

In 1998, Congress directed the National Park Service, in cooperation with other federal and nonfederal partners, to establish the National Cave and Karst Research Institute in the area of Carlsbad, New Mexico. The institute's emphasis is on partnerships, research, and education for the improved management of cave and karst resources.

In July 2000 an interim director, Zelda Chapman Bailey, was hired to define the institute's purview and scope of operation, design the organizational structure, find funding sources, form partnerships, locate a facility, and identify specific research needs and priorities. Bailey has more than 20 years of experience as project chief and manager with the USGS Water Resources Division, working in several states. She also has expertise in developing partnerships with other agencies in managing challenging organizational situations.

◀ **Improving the understanding** of delicate cave formations such as these "snake dancer" helictites in the Guadalupe Mountains of New Mexico (and cave resources throughout the country) is a fundamental goal of the National Cave and Karst Research Institute.
Ronal Kerbo

Mapping the floor of America's deepest lake with sonar

✎ By William M. Brock

✉ mac_brock@nps.gov
Chief, Resource Preservation and Research; Crater Lake National Park, Oregon

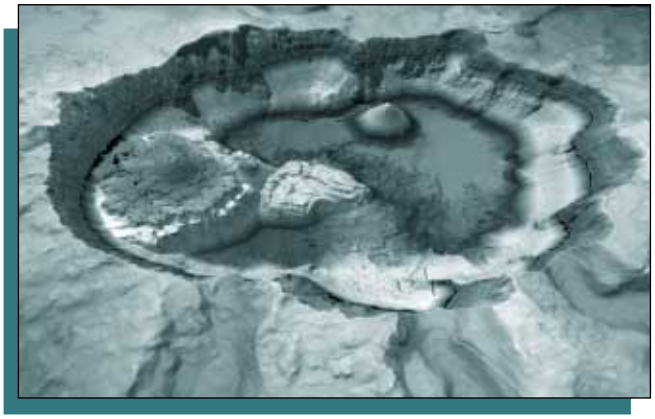
In 1886, scientists of the U.S. Geological Survey took the first-ever measurements of the depth of Crater Lake (Oregon) in various locations. From a rowboat lowered by ropes to the lake surface, they used a spool of piano wire with lead weight and leather tabs to record depths. They took about 100 measurements and recorded a maximum depth of 1,996 feet (609 meters). In 1959 other scientists provided another glimpse of the lake floor and a new official depth of 1,932 feet (589 meters). Their methods, although sophisticated for the day, could provide only a crude understanding of the lake floor.

One hundred fourteen years after the first depth recording, the staff of Crater Lake National Park repeated the measurements. In cooperation with the U.S. Geological Survey, in 2000 they completed a comprehensive survey of the floor of Crater Lake with state-of-the-art, multibeam sonar technology. This time an 11,200-pound (4,178-kilogram), 26-foot (8-meter) research vessel, *Surf Surveyor*, was used for the mapping. It was trucked from Louisiana and then transported by a U.S. Army Reserve Chinook helicopter 1,000 feet (305 meters) from the rim of the caldera to the lake surface.

Scientists mapped the lake floor with the most advanced multibeam sonar equipment. Only six equivalent units are in service worldwide. The scientists took more than 16 million soundings and recorded, among other things, a maximum lake depth of 1,958 feet (597 meters), which is 26 feet (8 meters) greater than previously thought. The crew completed the survey in five days and the military retrieved the vessel from the lake surface.

Like the early explorers, scientists from the U.S. Geological Survey and managers from the National Park Service are exuberant about the results of the mapping. The new images of the geologic features are very precise and reveal amazing details of ancient lava flows, huge landslide debris fields, distinct submerged shorelines, and previously unknown drainage patterns formed before the lake filled. Information from these new data will launch geologists and volcanologists onto a new plateau of scientific investigations of the lake and its volcanic origins. The data may also provide clues to the evolution of volcanoes throughout the Cascade Range.

Mapping Crater Lake developed from an unusual compact begun in 1995 among attorneys, corporate executives, insurance adjusters, government officials, research scientists, and the military in a civil settlement under the Resource Protection Act (16 USC 19jj). Although the survey phase of the research on the lake is now complete, the park and the scientific community will continue to reap its benefits and build upon the results for years, if not decades, to come.



▲ **This computer-generated map** of Crater Lake, Oregon, is the result of recent surveys using state-of-the-art, multibeam sonar for the acquisition of soundings. The new depiction is the most detailed to date and reveals submerged shorelines, lava flows, landslide debris fields, and a maximum depth of 1,958 feet.
U.S. Geological Survey

New moth and butterfly species identified in the Smokies

As part of Great Smoky Mountains National Park's All Taxa Biodiversity Inventory, in the summer of 2000 a lepidoptera "bio-blitz" inventory sparked great interest. This effort involved more than 20 professional and amateur lepidopterists collecting (if necessary) and identifying as many moth and butterfly species as possible during a 24-hour period. A one-day inventory like the lepidoptera bio-blitz has never been done on this scale before. The results amazed even the scientists involved with the finding of 706 species, including 327 new distributional records. The number of lepidopteran species known to occur in the park, is now up to 1,100; however, experts believe that the actual total is closer to 3,500.

The All Taxa Biodiversity Inventory is a 10- to 15-year effort intended to comprehensively document all life-forms in Great Smoky Mountains National Park (North Carolina and Tennessee). The current tally of all species new to science recorded during the inventory, which is in its fourth year of operation, is 80; the total number of new park records, not counting the 80 new species, is 620. The park staff hopes to hold more of these bio-blitz events in the future.

The luna moth (*Actias luna*), common in the eastern United States, was one of many lepidopteran species inventoried during a 24-hour "bio-blitz" in summer 2000 at Great Smoky Mountains National Park. ▶

Award-Winner Profile — Dr. Howard Ginsberg honored

▲ **Dr. Howard Ginsberg** in his laboratory at the University of Rhode Island. Michael Salerno, University of Rhode Island

Michael Soukup, Associate Director, Natural Resource Stewardship and Science, presented the annual Director's Award for Natural Resource Research to Dr. Howard Ginsberg at the annual natural resources meeting in Missoula, Montana, in June 2000. Dr. Ginsberg is a research ecologist with the USGS Biological Resources Division, stationed at the University of Rhode Island. He was honored for research and technical assistance he provided in 1999 to national park units on the west Nile virus, and for his research on the tick *Ixodes scapularis*, the primary vector of Lyme disease in North America.

The west Nile virus, native to southern Europe, the Middle East, and Africa, is a mosquito-borne disease that is deadly to wildlife and people. The virus can result in fatal encephalitis (inflammation of the brain) in humans and horses, as well as kill certain domestic and wild birds (particularly crows) and mammals. It is believed to have been introduced into the United States in 1999, when it made 62 people seriously ill and killed 7 people in New York City. The virus is spreading through the New England and Mid-Atlantic states and could become a nationwide problem.

Dr. Ginsberg provided critical support to Fire Island National Seashore and Gateway National Recreation Area, the two park sites nearest the 1999 outbreak, as well as other Northeast Region coastal parks, in assessing the disease risk of the virus during the 1999 breeding season. He wrote detailed surveillance and management protocols for the two parks, which established comprehensive monitoring programs and tied management actions to the surveillance data. He also helped other parks in the area, including Assateague Island National Seashore and Delaware Water Gap National Recreation Area, to set up similar but less detailed programs. In addition, Dr. Ginsberg's research and knowledge of mosquito ecology prevented the local Suffolk County (New York) Vector Control Agency from spraying saltmarsh mosquitoes with malathion, a chemical pesticide, in the Fire Island National Seashore Wilderness Area.

The west Nile virus can adversely affect park resources by directly impacting wildlife populations. Efforts to control the disease, such as pesticide applications, can also adversely affect parks. In an interview after winning the award Dr. Ginsberg observed, "The best way to minimize these negative effects is to monitor vector and wildlife populations to determine the level of risk, and to target interventions as efficiently as possible. If interventions are not needed, based on surveillance data, do not intervene. If interventions are needed, use interventions that will work (to minimize the need for future interventions), and target them carefully to minimize effects on park resources."

Dr. Ginsberg deeply appreciates being recognized by the National Park Service. "I have always felt a strong connection to the national parks, and I hold the people I have worked with in very high regard…. To be recognized by these fine and dedicated people is a high honor indeed."

"New" waterfalls discovered in Yellowstone

A book published in 2000 amazingly documented for the first time more than 240 "new" waterfalls in Yellowstone National Park. *The Guide to Yellowstone Waterfalls and Their Discovery* was based on seven years of research and off-trail exploration by its three disciplined and adventurous authors. The discovery of these waterfalls has increased the understanding of Yellowstone's geography and has added new, albeit in most cases remote, attractions for visitors. The waterfalls are also barriers to fish, including the Yellowstone cutthroat trout (*Oncorhynchus clarki*), a species that historically occurred throughout the park but now has been reduced to isolated populations. Park staff used the information on the waterfall locations to create a digital fish barrier layer in their geographic information system. This information will assist them in determining the distribution of the trout and in developing future strategies for conserving and restoring this species.

◀ **Citadel of Asgard Falls,** documented for the first time in 2000 in Yellowstone National Park, Wyoming. Copyright Paul Rubinstein

Forging Partnerships

What does NASA have to do with the National Park Service?

✎ By Anita Davis

✉ anita_davis@nps.gov
Liaison to NASA Goddard Space Flight Center, NPS Division of Interpretation, Greenbelt, Maryland

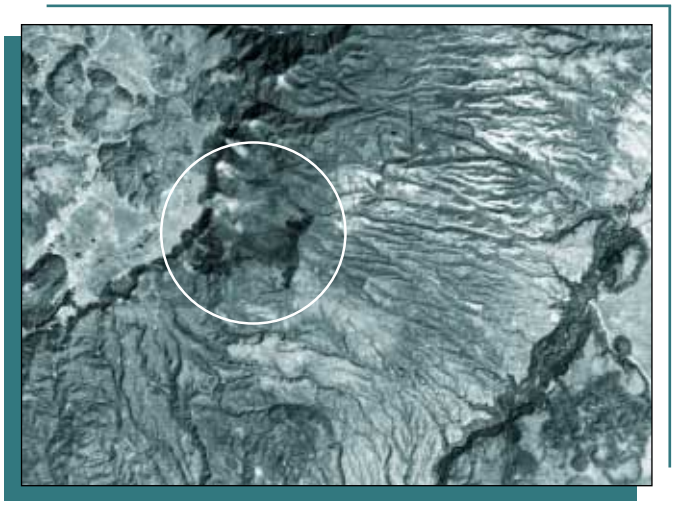
A lot! In 1998, at the request of Goddard Space Flight Center in Greenbelt, Maryland, a partnership between the two agencies began with the filling of the first one-year detail assignment of an NPS liaison to NASA. The incumbent is on staff of the NPS Division of Interpretation in Washington, D.C.; the position is funded by NASA.

The space program offers many products and services that can support the Park Service's Natural Resource Challenge, in particular the call for increased collaboration with scientists and the expanded use of parks as research locales. Goddard Space Flight Center is NASA's lead center for the Earth Science Enterprise, whose scientists study deforestation, wildfires, volcanism, air quality, urban growth, plankton distribution, decline of coral reefs, and glacial retreat—topics of obvious relevance to NPS resource preservation efforts. Because of this emphasis at Goddard, the liaison position offers a perfect opportunity to explore possible connections between NASA's earth scientists and national park research needs, thus supporting the goals of the Challenge.

In 2000 the partnership provided information about the Earth Science Enterprise's work and possible applications for resource management posted to NPS bulletin boards. Ongoing research produced satellite images of fires in summer 2000 that were posted on the NPS website and internal bulletin boards for staff use. Also, some NASA programs, most notably Landsat 7, gave technical assistance to parks. Dialogues with NASA personnel studying uses of hyperspectral data led to new remote sensing data and imagery for selected parks in Florida.

Collaboration with the Park Service is not entirely new to NASA. In recent years, research on LIDAR technology (a laser version of radar) produced detailed mapping and monitoring of beach erosion for Assateague Island National Seashore, Maryland. But the partnership has also helped other Goddard scientists become aware of NPS interests. Some inquired about desirable research and offered to help parks in data acquisition. For example the Landsat 7 team helped Delaware Water Gap National Recreation Area, Pennsylvania, acquire and process data to analyze land use change in the Delaware River watershed. The satellite images provide information over the entire watershed that is not obtainable from maps.

New technologies can and do support preservation of park resources. Land managers and researchers are already using data from the new MODIS instrument (*Mod*erate-resolution *I*maging *S*pectroradiometer) aboard the satellite Terra for studying effects of wildfires. Instruments providing better land-imaging data are being tested in the recently launched EO-1 satellite, and the satellite Aura (launching in 2003) will allow analysis of air quality with unprecedented accuracy. Some NASA scientists are interested in working in national parks to "ground-truth" such new instruments, which would yield valuable data and information for both agencies.



▲ **A combination thermal and visible spectrum image** of the Cerro Grande fire in Bandelier National Monument, New Mexico (circled), was captured on 9 May 2000 by the Landsat 7 satellite 427 miles in space. It is a good example of the remote sensing imagery available to parks that has application in resource management. Although difficult to see in this reproduction, the full-color image readily reveals the fire perimeter and levels of fire intensity. When compared with subsequent views of the area, this information is useful in determining site recovery or indicating the need for rehabilitation. The full-color image can be viewed at http://visibleearth.nasa.gov/cgi-bin/viewrecord?588. Parks wishing to purchase Landsat data may do so through the EROS Data Center (http://edcwww.cr.usgs.gov/index.html) for $600 per data set. The data are not copyrighted and may be shared without restriction.

NASA Earth Observatory; http://earthobservatory.nasa.gov

The agencies' partnership also spawned Introduction to Remote Sensing for Park Rangers, a course to be offered jointly by the Park Service and the U.S. Fish and Wildlife Service at the National Conservation Training Center in Shepherdstown, West Virginia, in May 2001, and funded with a grant from NASA. It is open to anyone from the sponsoring agencies.

As natural resource managers and scientists of the National Park Service increasingly use NASA technologies, collaboration between the two agencies will soon be common. The NPS liaison in the NASA Public Affairs Office welcomes questions, requests, and ideas for the partnership. The agencies' partnership will continue in 2001.

Further information on NASA's earth science research is available at http://earthobservatory.nasa.gov.

Satellite imagery used for long-term park monitoring

In 2000 the National Park Service joined the Multi-Resolution Land Cover Consortium, which provides access to Landsat 7 satellite data (33-yard or 30-meter resolution) and land-cover mapping products for free or at a reduced price. Satellite imagery is a method for taking a snapshot of a park's resources in their regional context. Landsat 7 and higher-resolution imagery offers an excellent opportunity for mapping, monitoring, and discovering ecosystem patterns and processes. Further information on the use of imagery is available at http://edc.usgs.gov/earthshots/slow/tableofcontents.

Leslie Armstrong (leslie_armstrong@nps.gov) and Mike Story (mike_story@nps.gov) of the National Park Service are available to assist parks in purchasing Landsat or other types of satellite imagery. The NPS Inventory and Monitoring Program maintains a long-term archive of imagery that includes all new purchases by parks. To help park staff learn what imagery is available from federal and commercial sources, a Microsoft Access database called the Imagery Database was assembled and posted at www.nps.gov/gis/national_data.htm.

This map of unplanned "social" trails (short, dark lines) at Cape Cod National Seashore, Massachusetts, was derived from high-resolution imagery. It serves as a baseline for monitoring the effectiveness of management strategies to reduce the development and natural resource impacts of such trails.

First Canon National Parks Science Scholars retreat

Eleven of 13 National Parks Science Scholars attended the Canon retreat outside Yellowstone National Park on 11–14 May 2000. The retreat focused on the relationship among science, the media, and the public. Pulitzer Prize–winning journalist William Dietrich gave a speech on communicating science to the public. Seven new 2000 Canon Scholars were announced and 1997 scholars Andy Suarez and Ilene Grossman-Bailey were recognized for completing their doctorates. Andy earned his degree in biology at the University of California, San Diego. His dissertation was titled "Measuring the Impact of Exotic Species in Natural Systems." Much of his research was conducted in Cabrillo National Monument. Ilene earned her degree at Temple University, Philadelphia. Her dissertation was titled "Native American Resource Use in the New Jersey Outer Coastal Plain." Ilene's fieldwork was conducted at sites in the Pinelands National Reserve and along the New Jersey Coastal Heritage Trail Route.

The Canon National Parks Science Scholars Program was established in 1997 with the purpose of developing the next generation of scientists working in the fields of conservation, environmental science, and park management. It is the first and only program of its kind to encourage doctoral students to conduct research on problems critical to the national park system. The program is underwritten and supported by Canon U.S.A., Inc.

Recent Canon Scholar graduates Andy Suarez (top) and Ilene Grossman-Bailey